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Assessment of physicochemical parameters with its effects on human and aquatic animals giving special preference to effective management of Turag River

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Abstract: *Rapid acceleration of urbanization and industrialization in Bangladesh has been coupled with increasing environmental degradation. The present study was carried out to investigate the air, water and sediment quality which are degraded due to pollution load at Turag River. Gastec technique (Japanese origin) is used to determine the CO, CO_2, NO_x and SO_2 concentration and the concentration range for CO: 2425-7635 μg/m ^{3}, 82-652 μg/m ^{3} for NO_x, 151.93-553.56 μg/m ^{3} for PM_{10} and 395-510 μg/m ^{3} for CO_2.Atomic absorption spectrophotometer technique is used for the determination of Cr, Pb, Zn, Cu and Cd because of their potential toxicity. As per US EPA sediment quality guideline, metal concentrations ranged between Cd: 0.10 - 0.90, Cr: 31.00 - 78.20, Cu: 48.10 - 69.00, Pb: 30.30 - 37.20, and Zn: 95.60 - 191.10 mg/kg in the Turag river sediments. Occurrence of both the air pollutants and sediment heavy metal shows significant difference at different station that is analyzed by using ANOVA (SPSS V.17) test. Major pollution sources are domestic sewage, industrial waste, commercial waste, agricultural waste, institutional waste, street sweepings, construction debris, mining activities and sanitation residues combustion of fuel, thermal, nuclear power plants, vehicular pollution and nuclear combustion etc. solid waste pollution, heavy metal pollution, organochlorine pesticides pollution and oil pollution are the main pollution that are highly responsible for environment degradation. Air temperature, Water temperature, pH, EC, Chloride, Turbidity, TS, TDS, DO, BOD_5, and COD concentration in water samples were found to range from 26-36(°c), 29-34(°c), 7.5-7.9, 1850-1900(μScm$^{-1)}$, 32-42(mg/L), 13.5-14.4cm, 902-970(mg/L), 810-850(mg/L), 0-0(mg/L), 21-24(mg/L), 106-141(mg/L).Higher concentration of heavy metal is detrimental to human and aquatic animals for physical disorder. Fisher folk are suffering from various diseases like irritation and skin disease. Notwithstanding urbanization enhancing the individual family income and reform the social structure but traditional occupations like fishing are at the point of extinction.*
Keywords: *Environment, ANOVA, Degradation, Heavy metal, Fisher folk, Management*

I. Introduction

Turag River flowing along the side of the Dhaka City, the capital of Bangladesh, is one of the most polluted rivers in Bangladesh (Banu *et al*., 2013). Volcanism, bedrock erosion, atmospheric transport and the release from plants are considered as natural sources (Khan et al. 1996; Pekey *et al.* 2004) and anthropogenic activities; particularly, mining and mineral processing have dominant influences of primary water and soil quality parameters. Many industries have set up in and around the Dhaka City during last decade, and the number of new industries are continually increasing (DoE, 1997). The most vital and crucial element among the natural resources is water, crying need for the survival of all living organisms including humans, for food production and economic development (Shiklomanov, 1993; Pahl-Wostl *et al*. 2008). In recent time, nearly 40 % of the world's food supply is grown under irrigation, and a wide variety of industrial processes depend on water (BCAS, 2000). Notwithstanding, water is inevitably essential but the water of Turag river is being polluted by industrial units (Banu *et al*., 2013). Severe pollution occured at Buriganga Third Bridge area at Bashila and the Tongi Bridge area. At these two points, the river water is pitch- black with the worst of smell and can be used hardly for any purpose. Moreover, near the Tongi Bridge extreme pollution occurred that derives massive pollutant loading from the Tongi Industrial Area that includes about 29 heavy industries and generates a lot of effluents daily, which contain lots of heavy metal. Cd, Cr, Pb, Zn, Fe and Cu that found in contaminated soils (Akoto *et al*, 2008) that generated from vehicle exhausts, as well as several industrial activities (Ghrefat and Yusuf, 2006). Elevating nutrients leading to eutrophication and pollution in the aquatic environment (Nriagu and Pacyna, 1988; Peierls et al. 1998; Holloway et al. 1998; Li et al. 2009; Pekey et al. 2004, Venkatramanan et al. 2013, 2014a, b). The symptoms of toxic heavy metal poisoning and the symptoms of autism, PDD, Aspergers, & ADD/ ADHD are very similar. Toxic metals could be the cause of those symptoms. Memory loss, increased allergic reactions, high blood pressure, depression, mood swings, irritability, poor concentration, aggressive behavior, sleep disabilities, fatigue, speech disorders, high blood pressure, cholesterol, triglycerides, vascular occlusion, neuropathy, autoimmune diseases, and chronic fatigue are just some of the many conditions resulting from ex- posure to toxins (Thomilson et al. 1980; Ghrefat and Yusuf, 2006). Drowsiness, eye irritation, throat irritation, persistent cough, asthma, nose blockage, respiratory infections, bronchial infections, colds and headaches in human being are the result of air pollution (Ahmmed et al. 2010). Though river ecosystem play a critical role in terms of the ecology and the economy, but researches on Turag River in Bangladesh is not mentionable. The reason of this no systematic researches have been carried out on the water quality and their effects on aquatic lives along the Turag river that led us to continue this research with aim(1) to know the water and air quality (2) to know the effects of pollution and its sound management.

II. Materials and methods

Water and sediment samples were collected from Tongi Bridge (90˚24'4.12"E-23˚52 '54.21"N), World Estema Field (90˚23'36.98"E-23˚52 '45.54"N), Kamarpara Bridge (90˚23'23.56"E-23˚53 '25.68"N), Taltola Bridge (90˚22'40.92"E-23˚53'54.93"N) and Ashulia Beri Bandh (90˚21'37.45"E-23˚53 '23.34"N). The Bio-chemical Oxygen Demand (BOD) Chemical Oxygen Demand (BOD), Total dissolved solid and Total suspended solid were analyzed by the method stated by APHA, 2005. Dissolve Oxygen (D.O) determined by according to Azide Modification of Winkler (1988). The value of Hydrogen-ion-Concentration (PH) of Water was determined by using PH paper (color PH indicators strips, Cat.9585, made in Germany). Heavy metal (Cd, Cr, Hg, Pb were analyzed by using air acetylene flame with combination as well as single element hollow cathode lamps into an atomic absorption spectrophotometer Shimadzu, AAS-6800 (Ahmed et al, 2010; Subramanian, 2012). Air sample analysis. Gastec technique (Japanese origin) is used for CO, CO_2, NO_x and SO_2 concentration determination. High Volume Air Sampler (Graseby Andersen) is used for PM_{10} concentration determination. Experiments are conducted in accordance with the procedure recommended by the manufacturers of the equipment.

III. Results

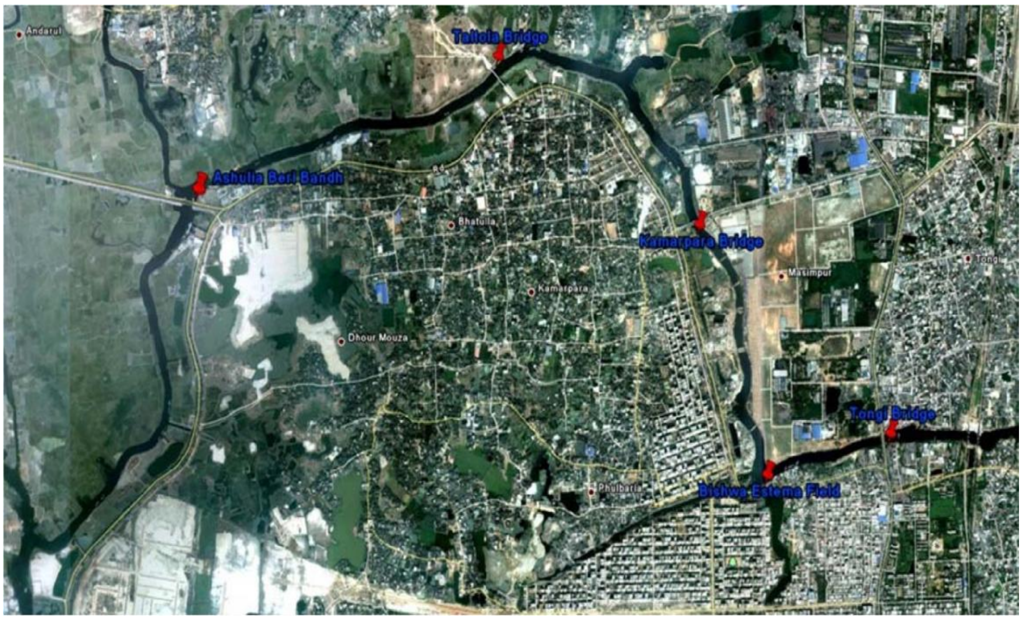

Figure 2. Location of coordinates of different sites in Turag river.

Table-1: Physical and chemical parameters of Turag river water

At Turag River the ambient water quality with respect to CO, SO_2, NO_x, CO_2 and PM_{10} is documented in Table-2.

Parameter	Station-1	Station-2	Station-3	Station-4	Station-5

Air temperature (°c)	27	32	26	35	36
Water color	Pitch black	Pitch black	Pitch black	Pitch black	Pitch black
Water temperature (°c)	29	31	28	34	33
pH	7.5	7.8	7.9	7.5	7.7
EC (μScm^{-1})	1850	1900	1875	1888	1867
Chloride(mg/L)	36	38	42	34	32
Turbidity(cm)	13.6	14	14.4	13.7	13.5
TS(mg/L)	920	970	953	941	902
TDS(mg/L)	823	850	830	810	814
DO(mg/L)	0	0	0	0	0.1
BOD(mg/L)	24	23	22	21	22
COD(mg/L)	106	120	141	123	112

Location	**Pollutant's Concentration**					**Amended Bangladesh Standards [ECR,2005]**	
	CO ($\mu g/m^3$)	**NO_x ($\mu g/m^3$)**	**SO_2 ($\mu g/m^3$)**	**PM_{10} ($\mu g/m^3$)**	**CO_2 (ppm)**	**Pollutant's Concentration ($\mu g/m^3$)**	
Tongi Bridge	2425	363	Trace	553.56	465	SO_2	365
World Estema Field	7635	652	Trace	270.92	395	CO	10000
Kamarpara Bridge	5530	334	Trace	380.46	497	NO_x	100
Taltola Bridge	2435	82	Trace	151.93	498	PM_{10}	150
Ashulia Beri Bandh	4926	110	Trace	187.64	510		

Table-2: Ambient Air Quality of Turag River

Table-3: One-Way Analysis of Variance of CO at different station in Turag River

CO	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	9.800E7	4	2.450E7	1.053E8	.000
Within Groups	4.653	20	.233		
Total	9.800E7	24			

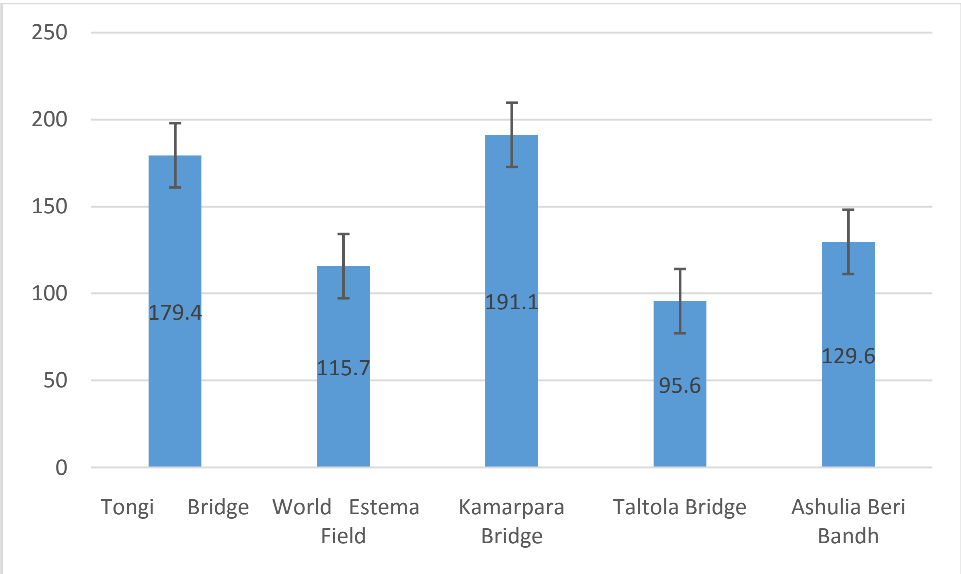

Figure-1: Standard error bar shows significant difference of CO concentration at different station in Turag River

Table-4: One-Way Analysis of Variance of NOx at different station in Turag River

NOx	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1061584.000	4	265396.000	1698534.400	.000

Within Groups	3.125	20	.156		
Total	1061587.125	24			

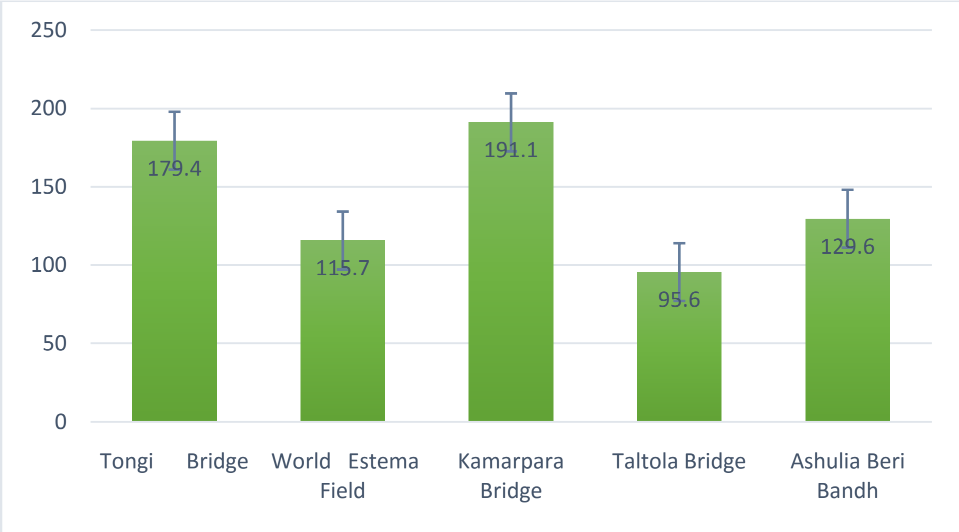

Figure-2: Standard error bar shows significant difference of NO_x concentration at different station in Turag River

Table-5: One-Way Analysis of Variance of PM_{10} at different station in Turag River

PM_{10}	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	529118.985	4	132279.746	5678217.132	.000
Within Groups	.466	20	.023		
Total	529119.451	24			

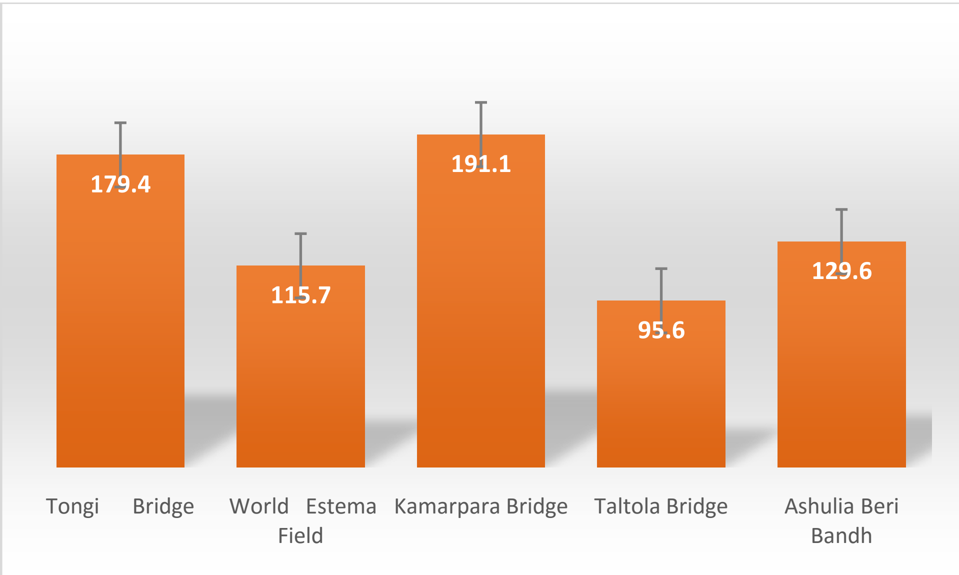

Figure-3: Standard error bar shows significant difference of PM_{10} concentration at different station in Turag River

Table-6: One-Way Analysis of Variance of CO_2 at different station in Turag River

CO_2	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	43621.108	4	10905.277	68670.435	.000
Within Groups	3.176	20	.159		
Total	43624.284	24			

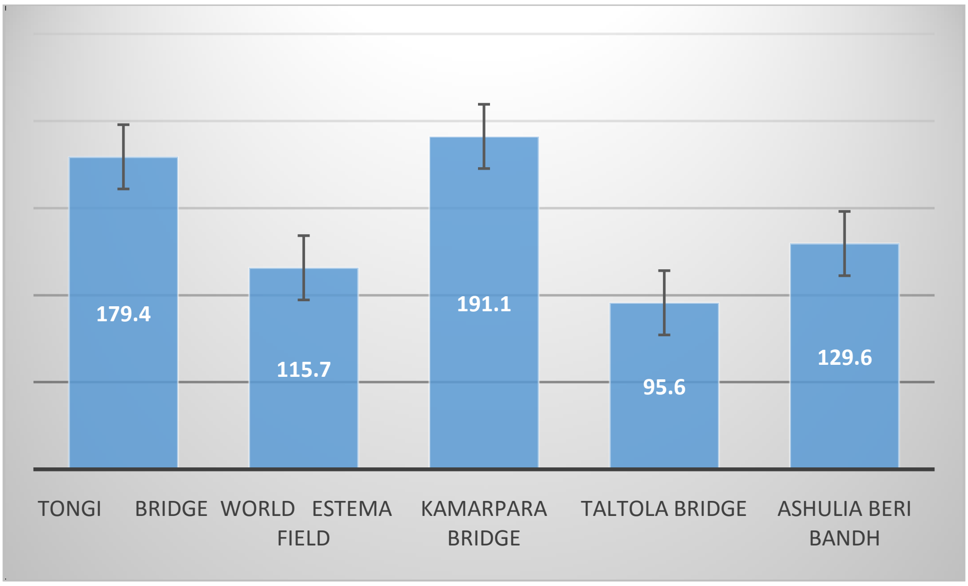

Figure-4: Standard error bar shows significant difference of CO_2 concentration at different station in Turag River

Table-7: Concentration of heavy metals (mg/kg dry weight) of sediments of Turag River.

Location	Lead (Pb)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
Tongi Bridge	37.20	0.20	36.60	69.00	179.40
World Estema Field	34.70	0.30	34.60	48.10	115.70
Kamarpara Bridge	31.40	0.10	78.20	47.75	191.10
Taltola Bridge	30.30	0.30	31.00	51.00	95.60
Ashulia Beri Bandh	35.60	0.90	39.50	49.80	129.60
Mean±SD	33.84±2.899	0.36±0.313	43.98±19.378	53.13±8.968	142.28±41.254
Max	37.20	0.90	78.20	69.00	191.10
Min	30.30	0.10	31.00	47.75	95.60

Table-8: One-Way Analysis of Variance of Lead at different station in Turag River

Lead	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	173.042	4	43.260	15916.263	.000
Within Groups	.054	20	.003		
Total	173.096	24			

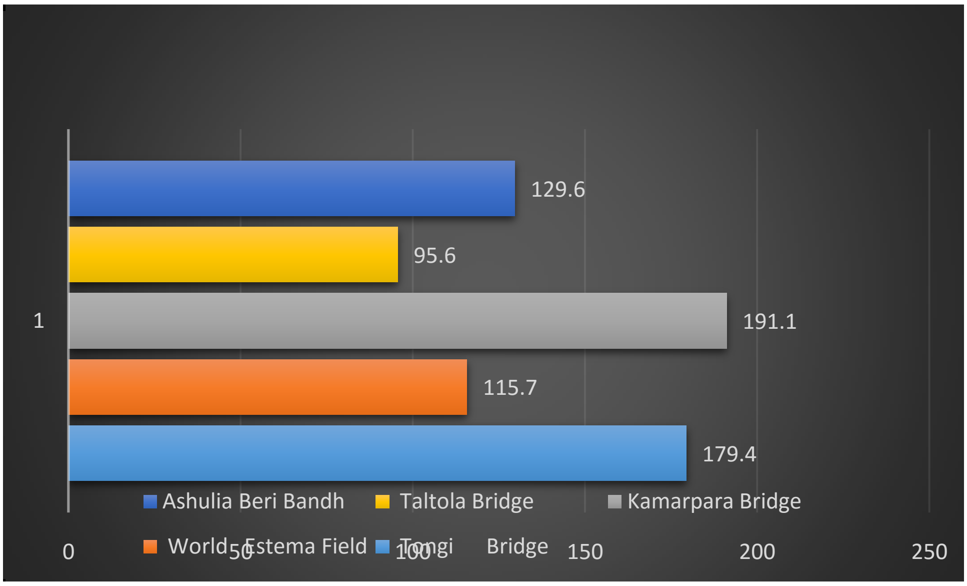

Figure-5: Bar chart shows significant difference of Lead concentration at different station in Turag River

Table-9: One-Way Analysis of Variance of Cadmium at different station in Turag River

Cadmium	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1.993	4	.498	2147.353	.000
Within Groups	.005	20	.000		
Total	1.997	24			

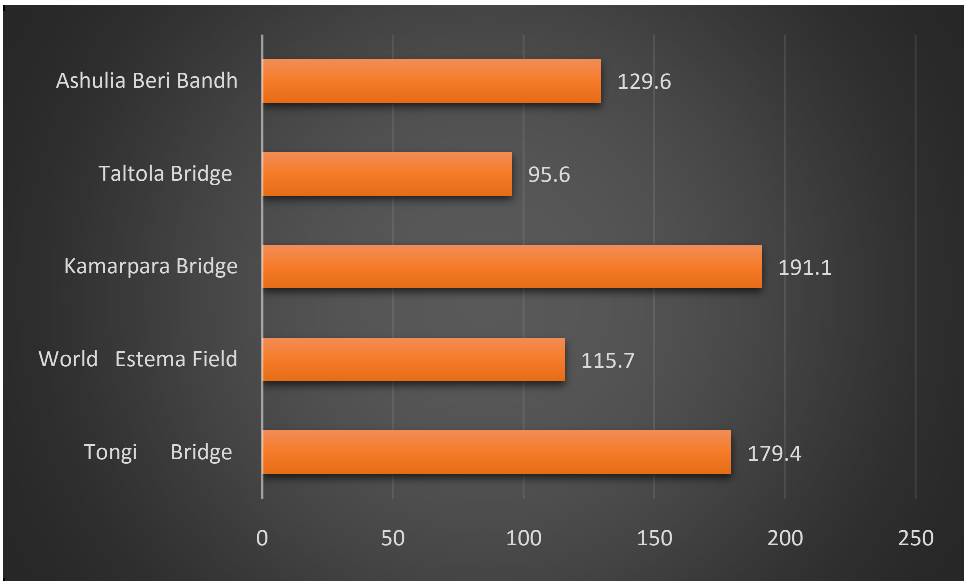

Figure-6: A clustered bar chart shows significant difference of Cadmium concentration at different station in Turag River

Table-10: One-Way Analysis of Variance of Chromium at different station in Turag River

Chromium	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	7503.485	4	1875.871	380810.259	.000
Within Groups	.099	20	.005		
Total	7503.584	24			

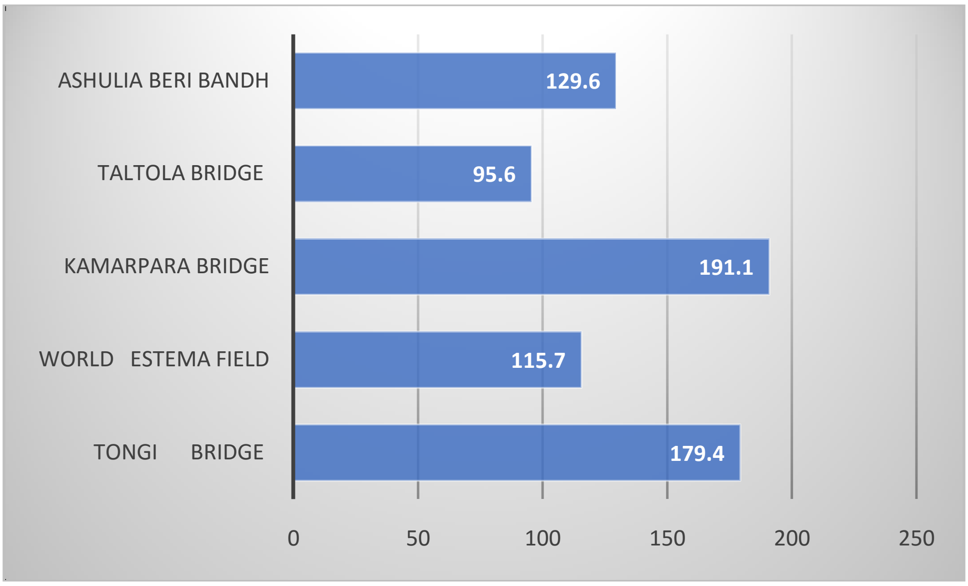

Figure-7: A clustered bar chart shows significant difference of Chromium concentration at different station in Turag River

Table-11: One-Way Analysis of Variance of Copper at different station in Turag River

Copper	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1606.574	4	401.643	36387.333	.000
Within Groups	.221	20	.011		
Total	1606.794	24			

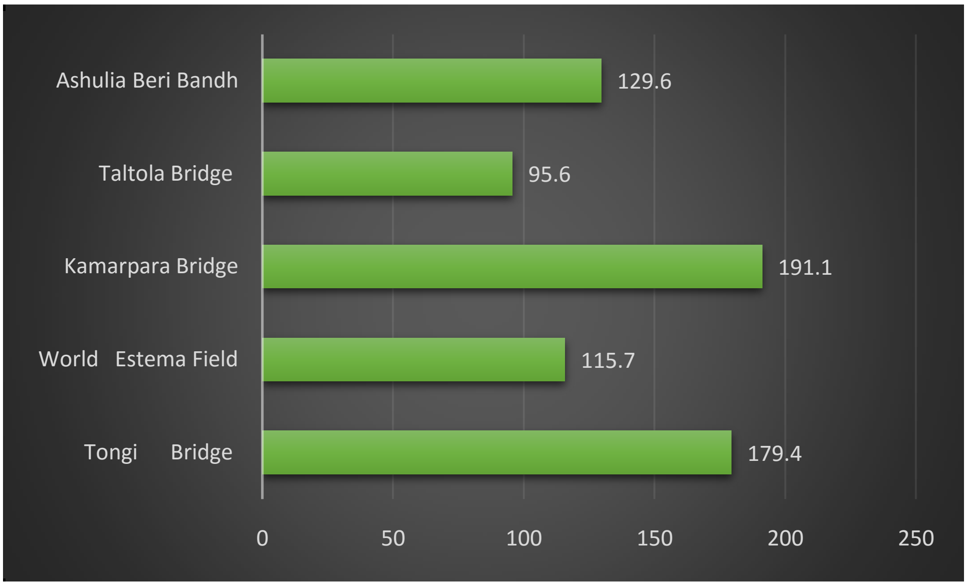

Figure-8: A clustered bar chart shows significant difference of Copper concentration at different station in Turag River

Table-12: One-Way Analysis of Variance of Zinc at different station in Turag River

Zinc	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	34097.296	4	8524.324	1144819.229	.000
Within Groups	.149	20	.007		
Total	34097.445	24			

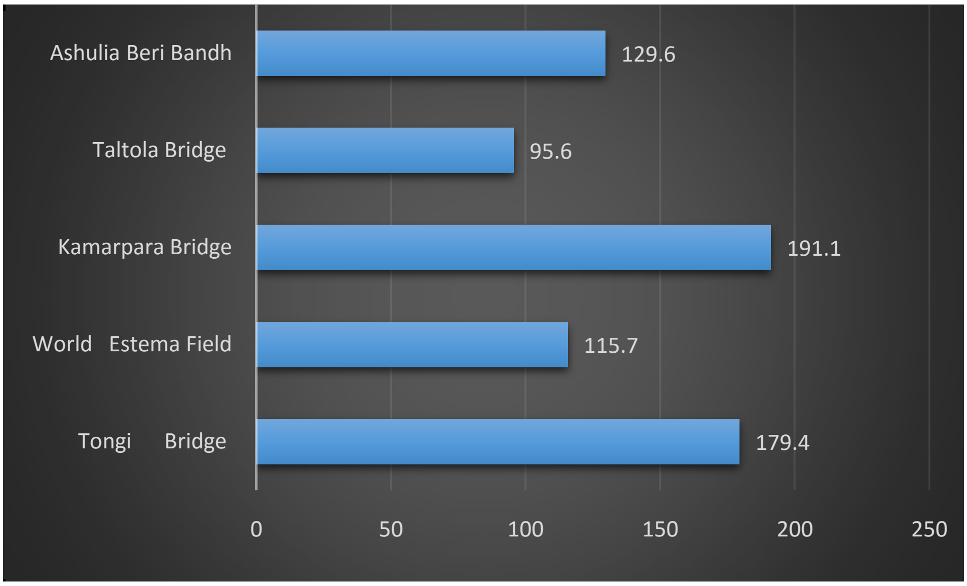

Figure-9: A clustered bar chart shows significant difference of Zinc concentration at different station in Turag River

IV. Discussion

From the present physicochemical study of the water quality of the Turag River, it can be mentioned that the recent condition of Turag River is critical. DO value found for the Turag River was 0 mgL^{-1} for five station which indicates the critical condition of this River and it became a dead river stated by (Ahmed et al. 2010). More or less similar observations were also recorded by Gasim et al. (2007), Alam et al. (1996),Jashimuddin and Khan (1993), Hossain and Khan (1992), Islam and Khan (1993), Hossain et al. (1988), Bhuyian (1979), Khan et al. (1976) and Mahmood and Bhuyian (1988). The value of pH showed slightly alkaline in nature. Roy (1955), Moore (1972), APHA (1976), Mahmood and Bhuyian (1988), Sarma et al., (1982) and Campbell (1978) stated that the industrial or municipal waste materials had a significant role in increasing or decreasing pH of the adjacent water body where the waste materials were dumped. This statement closely agreed with the present investigation (Hossain et al. 2005).The BOD varied from 21-24 mg/L, nearly similar result observed by Kamal et al. 2007 at Mouri River. River water contains BOD more than 10mg/L is considered to be moderately and more than 20 mg/L as to be highly polluted water (Paul, 1999). COD ranges from 106-141 mg/L, closely similar result found by Jamaluddin and Nizamuddin(2012) who studied in Chittagong region and Miah(2012) who studied in wastewater. Nian et al. (2007) reported that higher COD concentration can cause a substantial damage to submersed plants. Like BOD, higher COD is also harmful to all aquatic life. The highest concentration of Pd found in Tongi Bridge 37.20 mg/kg. Khan et al. (1998) reported the Pb concentration ranged from 2.355 to 26.086 mg/kg in sediment in Ganges-Brahamputra-Meghna Estuary. Concentration of Zn found 95.60 - 191.10 mg/kg in the Turag river sediments that is more or less similar with the investigation result of Ashraful (2003) and Neff (2002). The concentration of Cd was found 0.10 - 0.90mg/kg which is nearly similar to the result of Siddique and Akter (2012) who studied trace metal in saltmarsh bed. The concentration of Cr ranged from 31.00 - 78.20 mg/kg which shows more or less similarity with the result of Saha and Hossain (2011) who studied Heavy Metal Contamination and Sediment Quality in the Buriganga River.The Department of Environment (DoE) and Government of Bangladesh (GoB) set the standard limits of air pollutants are included but from the experimental values, it is apparent that in terms of PM_{10} the situation is alarming which shows similar result with the result of Begum (2004) and Ahmmed et al. (2010). The concentration level of CO is within the limit of Bangladesh Standards [ECR, 2005]. But the concentrations of NO_x in the ambient air exceed the standard values set by the Department of Environment, GoB. But, it may be mentioned here that the standard value of NO_x set by the DoE is annual average. The above data indicate that the Turag River in Dhaka region are highly polluted though concentration of some anions and some metal generated due to heavy industrialization. Therefore these pollutants, when discharged, are polluting the water and nearby soil thus greatly rendering us a highly polluted environment.

Water Pollution and Industrial Pollution Control

- Preparing a mitigation plan to reduce environmental pollution in a proactive manner rather than a reactive measure
- Bangladesh River Basin Pollution Control Project.

- Pilot Project to Recycle and reuse of Textile Effluent
- Introduction of Environmental Management System (EMS) in Textile
- (Environment, Forestry and Biodiversity conservation, Background Paper for Seventh Five Year Plan).
- Promotion of ISO 14000 environment management principles
- Preparing a national database on different types of industries operating in Bangladesh including SMEs, in order to identify the industries for monitoring.
- Know the waste generation rate as well as pollution load from different industrial sectors and to identify polluting industries as well as their exact locations for monitoring.
- **Waste management**
- Commitment for technical up gradation of selected registered recyclers for processing E-waste.
- Assisting registered recyclers to establish Environmental Management System (EMS) and gradually work for ISO-14001 certification.
- Establish E-waste tracking mechanism in order to update the inventory.
- Development of Hazardous Waste Management Facility.
- Establishment of division wise lead recovery and recycling centres/ plants for used out lead acid batteries
- Formulation decision making structure for Mercury operation.
- Policy and regulatory framework, and institutional and capacity needs in regard to the implementation of convention provisions assessed.
- Sound Management of hazardous waste.
- Monitoring and Evaluation.
- Capacity Building & Generation of CDM Benefit through Composting of Organic Waste of Urban Center (City Corporation & Municipalities) in Bangladesh.
- Implementation of Waste Reduce Reuse and Recycle (3R) Bangladesh.
- Strengthening of institutional and regulatory framework for PCBs,
- Improve technical capacities for environmentally sound management of PCB contaminated equipment and waste meeting BAT/BEP requirements.
- Minimization/Elimination of uncontrolled POPS generation from the healthcare waste.
- Institutional capacity and advocacy programs.
- Implementation of Stockholm Convention requirements in all the stages of ship recycling.
- Inventory of E-Waste in large cities of Bangladesh.
- Develop E- Waste policy.
- Establish efficient collection system for selected electronic waste
- Registration of E-waste recyclers.
- Awareness raised on the environmental and health impacts of Mercury in each of the project countries.
- National capacity built to undertake mercury inventories.
- National Minamata ConventionInitial Assessments (MIA) report available each project country. (Environment, Forestry and Biodiversity conservation, Background Paper for Seventh Five Year Plan).

Policy and legislation

- Water Pollution Control Ordinance, 1970
- Environmental Pollution Control Ordinance, 1977
- National Environmental Policy, 1992
- Factories Act, 1965
- Fifth Five Year Plan (1997-2002):
- National Water Policy (NWP), 1999-
- National Policy for Safe Water Supply and Sanitation (1998)
- National Water Management Plan (NWMP), 2001
- National Agriculture Policy, 1999
- Pesticides Law,1985
- Integrated Pest Management
- National Environmental Management Plan, 1995
- Environmental Conservation Act 1995 (Revision up to 2012)
- Environmental Conservation Rules 1997
- Environmental Quality Standards, 1997
- Wetland Policy, 1998
- The National Water Policy, 1999
- The Environmental Court Act 2000
- The EIA Guidelines for Industry
- National Water Management Plan, 2001

- Bangladesh Water Act, 2013
- National Conservation Strategy (NCS)
- National Environment Management Action Plan (NEMAP), 1995
- Sustainable Environment Management Plan (SEMP)
- National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP)
- National Fisheries Policy
- Hazardous Waste and Ship Breaking Waste Management Rules, 2011
- National Water Policy (2012)
- Bangladesh Bio-safety Rules, 2012
- Odor Control Rules 2012.
- Brick Manufacture and Brick Kiln Installation (Control) Act, 2013
- Bangladesh Biological Diversity Act, 2013 (Cabinet approved in principle)
- Solid Waste Management Rules, 2013
- Ecologically Critical Area Management Rules, 2013.E-waste Rules, 2013.

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